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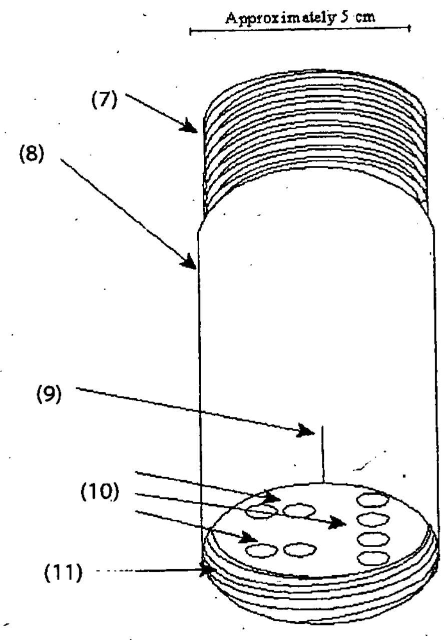
(54) Titre : DISPOSITIF ELECTRONIQUE D'ORIENTATION DE CAROTTE
(54) Title: ELECTRONIC CORE ORIENTATION DEVICE

Perspective of Sensor



(57) Abrégé/Abstract:
This invention provides a low cost, accurate and reliable core orientation method for inclined holes. The system consists of a sensor, display unit, specialized core tube, core tube alignment clip and where necessary, a customized drill rod extension. The sensor's components are: 3-axis accelerometer, clock, power source, programming and memory circuitry, shock absorbers and data transfer system, all encased in a standard diameter core tube extension. This sensor is attached to the top of the specialized core barrel during drilling. The sensor takes readings for core rotation and core inclination data for each core run, which may be used for other survey purposes. The specialized core barrel is aligned with the sensor, to facilitate accurate marking of the retrieved core. The display unit retrieves the core orientation data from the sensor and stores it on a memory card.

Electronic Core Orientation Device

Abstract of the Disclosure:

This invention provides a low cost, accurate and reliable core orientation method for inclined holes. The system consists of a sensor, display unit, specialized core tube, core tube alignment clip and where necessary, a customized drill rod extension. The sensor's components are: 3-axis accelerometer, clock, power source, programming and memory circuitry, shock absorbers and data transfer system, all encased in a standard diameter core tube extension. This sensor is attached to the top of the specialized core barrel during drilling. The sensor takes readings for core rotation and core inclination data for each core run, which may be used for other survey purposes. The specialized core barrel is aligned with the sensor, to facilitate accurate marking of the retrieved core. The display unit retrieves the core orientation data from the sensor and stores it on a memory card.

Core Orientation Patent Application

Field of the Invention:

The invention relates to diamond drilling, and more specifically to methods and tools to obtain the original position and orientation of drill core after retrieval from the ground.

Background of the Invention:

Core orientation is needed when mines do geotechnical surveys to assess fracture patterns in rock. By determining the fracture density and orientation of the fractures, companies are better equipped to design a safe mine layout. Core orientation is done by taking a number of measurements that allow the core's original position and orientation to be known. This requires at least a core rotation measurement, which can then be constrained by a downhole survey done after the hole is completed. Other techniques also get a dip measurement in addition to the rotation measurement, which can then be used to check the survey done when the hole is finished. Surveys that check the azimuth are not as reliable, since magnetic ore often makes these readings useless. Gyroscopes cannot be used while drilling takes place because of their sensitivity. ATV's (televiewers) are sometimes used to map fractures right off the walls of the drill hole, but these instruments are costly, require the surveyor to be nearby, and the risk of losing the probe down the hole is significant. Current methods of core orientation are highly expensive, unreliable, or require high maintenance.

On inclined drill holes, these disadvantages maybe overcome by using the proposed, robust electronic sensor attached to top of the core tube, which takes readings at prescribed times.

Brief Description of the Drawings:

Figure 1: Simplified Diagram of Drill String.
Figure 2: Perspective View of the of Sensor
Figure 3: Perspective View of the Core Tube and Sensor Setup
Figure 4: Perspective View of the Display Unit

Summary of the Invention:

The purpose of this invention is to provide a low-cost, accurate and reliable core orientation method for inclined holes. The system consists of a sensor, specialized core tube, alignment clip, display unit and, where necessary, a customized drill rod extension. The sensor's components are: electronic sensor, clock, thermometer, power source, programming and memory circuitry, shock absorbers and data transfer system, all encased in a standard diameter core tube extension. This sensor is attached to the top of the specialized core tube during drilling. The electronic sensor component (a 3-axis accelerometer in the preferred embodiment) takes readings used to give the core rotation data. The sensor unit can also give a core inclination measurement for each core run which may be used for other survey purposes. The specialized core tube is aligned with the sensor, to facilitate accurate marking of the retrieved core. The display unit is a computing device, which retrieves the core orientation data from the sensor and stores it on a memory card.

The optimum setup for the system uses 1), radio transmissions between the sensor and display unit when readings are taken; 2), a 3-axis accelerometer for the sensor tool, and 3), a method for the sensor to generate its own electricity. A backup method for data transfer and battery recharge is also included, where the sensor is plugged into the display unit. This system would cost less than scribing, and be more accurate than the other methods available for inclined holes.

Detailed Description of Invention:

Core drilling (Figure 1), is accomplished by the outer tube (4), which has a steel and diamond bit screwed to the bottom (5). Within the outer tube, the inner tube, also called the core tube (3) rests just above the drill bit (5). The core tube becomes filled with core as the drill bit on the outer tube cuts through the rock. During this drilling, water is flushed down the outer tube (4) (about 20-40 liters/min). The inner tube (3) is usually about 3m long and must be retrieved after every 3m interval is drilled. To retrieve the core tube (3), the core must be broken from the bottom of the hole by pulling up on the drill string (4). A retrieval tool is lowered by wireline and latches on to the backend (1) of the core tube (3) so that the core may be lifted from the hole.

For the proposed invention, the sensor (2) has to be powered up by attaching it to a battery charger using the connections at the bottom of the sensor. Once the sensor is working, the display unit (15) can be turned on and the sensor (2) plugged in. The operator sets the clock on the display unit (15) and synchronizes the display (15) with the sensor (2). If the radio option is available on the sensor (2), this may be done without connecting the sensor (2) to the display unit (15).

The sensor (2) is attached to the top of the core tube (3), below the backend (1), aligned with a clip (12) and lowered into the hole. Drilling commences once the core tube is at the bottom of the hole, and stops once three metres of core is drilled. In the preferred embodiment of the invention, the driller enters the depth of the hole on the display unit (15) and presses the "Take Reading " button. The display unit (15) transmits a signal to the sensor (2), which takes a reading and radios the measurements to the display unit (15) for storage. In case the radio system fails, the sensor (2) also takes readings every minute, which may be downloaded to the display unit (15) once the core tube (3) and sensor (2) are retrieved. If this is the case, the driller must wait for a 2-minute interval before breaking the core and he must enter the depth and time the reading was taken on the display unit (15). The driller may then break the core and retrieve the core tube (3). The sensor reference line (9) is in line with the core tube reference lines (13,14)(marked only at the top and the bottom of the tube, to limit weakening of tube). The driller then marks the location of the reference line on the core at the bottom of the core tube. With the reference line drawn on the core, the rotation measurement can be used to determine how the core was oriented in the hole.

The sensor components are (Figure 2): silicon 3-axis accelerometer, clock, thermometer, power source, programming and memory circuitry, shock absorbers and data transfer system, all encased in a standard diameter core tube extension (likely NQ size, with a 50mm internal diameter)(8). The power source provides the electricity for the other sensor components, either with the backup battery or with its generator. The generator harnesses either water flow, an alternating magnetic field, or vibration energy in the drill string. The accelerometer measures the orientation of the earth's gravitational force with respect to the sensor. The accelerometer is aligned with a reference line (9) etched into the outside of the sensor, so that the rotation readings obtained are with respect to this reference line. The clock measures the

time at which the accelerometer took the reading. The reading the thermometer measures is used to make temperature adjustments for the accelerometer reading. The programming and circuitry process the raw accelerometer data into meaningful rotation and inclination data. The memory circuitry keeps this data in storage until no longer necessary. The data transfer system uses either radio communications, or uses the backup connectors (10) on the bottom of the sensor to communicate the data to the display unit. Two of the connection points (10) on the bottom are used for charging the battery or capacitor in the sensor before use. The shock absorbers help protect the electronic components from shocks when the core tube is dropped down the outer tube. The sensor attaches to the top of the core tube (3), just below the backend (1). The sensor is sealed so that it may go down drill holes up to 3km deep without water leaking into the electronics.

The display unit (15) components are (Figure 4): large LCD with back light (16), radio transmitter and receiver, keypad with large buttons (17), sealed memory card port (18) and battery storage, port for radio antenna (22), port for external power source (21, preferably 12V, DC), port for sensor connection/data transfer (19), and internal circuitry for data input, storage and output. The display unit is extremely rugged and is weatherproof/waterproof. Buttons include: on/off, numbers 0 to 9, decimal point, delete, enter, take reading, take test, download, light, clock, and synchronize. The LCD displays both data and instructions for operation of the device, in English, French or Spanish. All ports are sealed and protected by plugs and covers to keep them clean and dry.

The core tube (3) is a standard size and design (about 3m long, 5cm internal diameter, screw threads at either end), apart from having reference lines etched at the top (13) and the bottom (14), and having a method of aligning the core tube reference line with that of the sensor (12). The clip (12) to align the two components is preferably a low-profile steel clip with raised points that fit into indents in the sensor and core tube, that ensure alignment. Other core tube sizes are envisioned depending on the drilling requirements. The original product is for NQ size drilling, but HQ and other sizes are also planned.

An additional drill rod extension (a custom length of drill rod with screw threads at both ends) accompanies the sensor to compensate for the extra length of the core tube (3) and sensor (2) assembly.

If the radio was not used, the driller must connect the sensor (2) to the display unit (15)(which is synchronized to the sensor) to download the correct reading. The readings are stored on internal and removable memory cards, so that if power is lost, the data can be retrieved later. The removable memory card can be given to the geotechnician responsible for orienting the core. The geotechnician can make all his measurements before or after using the sensor data to properly orient his readings. If he makes his measurements with regard to the reference lines drawn on the core, his readings can be transformed in the computer. Otherwise, he can use a modified protractor and draw the oriented top line on the core and make readings off of that.

It will be apparent that the invention has been described with reference to certain details of construction and these details should be interpreted as examples and not as limitations to the scope of the invention.

Claims:

1: A tool, fitting on the top of a core tube, below the backend, with the following components:
electronic sensor component (preferably silicon 3-axis accelerometer),
clock,
thermometer
power source,
radio transmitter and receiver,
programming and memory circuitry,
shock absorbers,
data transfer system (brass connection points and/or radio) ,
standard diameter core tube extension sensor casing (NQ, HQ, BQ or other standard size), with a reference line etched on it, aligned with the accelerometer inside.

2: A tool according to claim 1, wherein the sensor takes electronic readings of the Earth's gravitational field with respect to the orientation of the sensor, processes the reading into rotation and inclination measurements, and records the time these readings were taken.

3: A tool according to claim 1 wherein the readings obtained in claim 2 may be relayed to a display unit, either by direct contact or by radio transmission.

4: A tool according to claim 1, wherein batteries power the tool or, preferably, the tool can generate its own electricity or be charged without opening the sensor.

5: A core tube with reference lines etched at the top and bottom that has been modified to allow a clip to attach onto it. (ie: it has two 3mm diameter holes drilled in the top)

6: A tool according to claim 1 that has been modified to allow a clip to attach onto it. (two 3mm diameter holes drilled in the bottom)

7: A low-profile clip with four short pegs that fits over the join between the sensor and core tube, thereby aligning the two.

8: A display unit with the following components:
large LCD with backlight,
radio transmitter and receiver,
keypad with large buttons,
sealed memory card port,
battery storage,
port for radio antenna,
port for external power source (preferably 12V, DC),
port for sensor connection and data transfer,
and internal circuitry for data input, storage and output.

9: A display unit according to claim 11, wherein the depth and time of a measurement can be entered, the sensor can be attached to the data transfer port in the display unit for purposes of data transfer and clock synchronization, and the data obtained from the sensor can be stored on internal memory circuitry and on a removable memory card.

10: A method for obtaining the orientation of drill core comprising:

Attaching and aligning an electronic sensor tool to the top of the core tube,
Drilling a core from a substrate with a diamond drill,
Recording orientation data with the electronic sensor attached to the core tube,
Removing the drill core from the ground,
Marking the reference line from the sensor on to the core,
Correlating the sensor reading with the core to obtain a rotation measurement and the orientation of the core with respect to the Earth's gravitational field.

Figure 1: Simplified Perspective of Drill String Setup

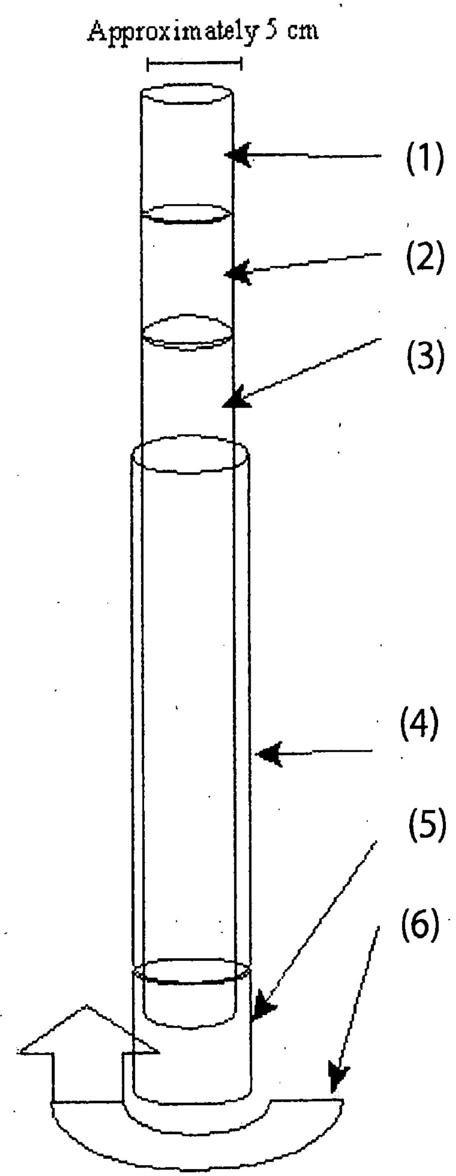


Figure 2: Perspective of Sensor

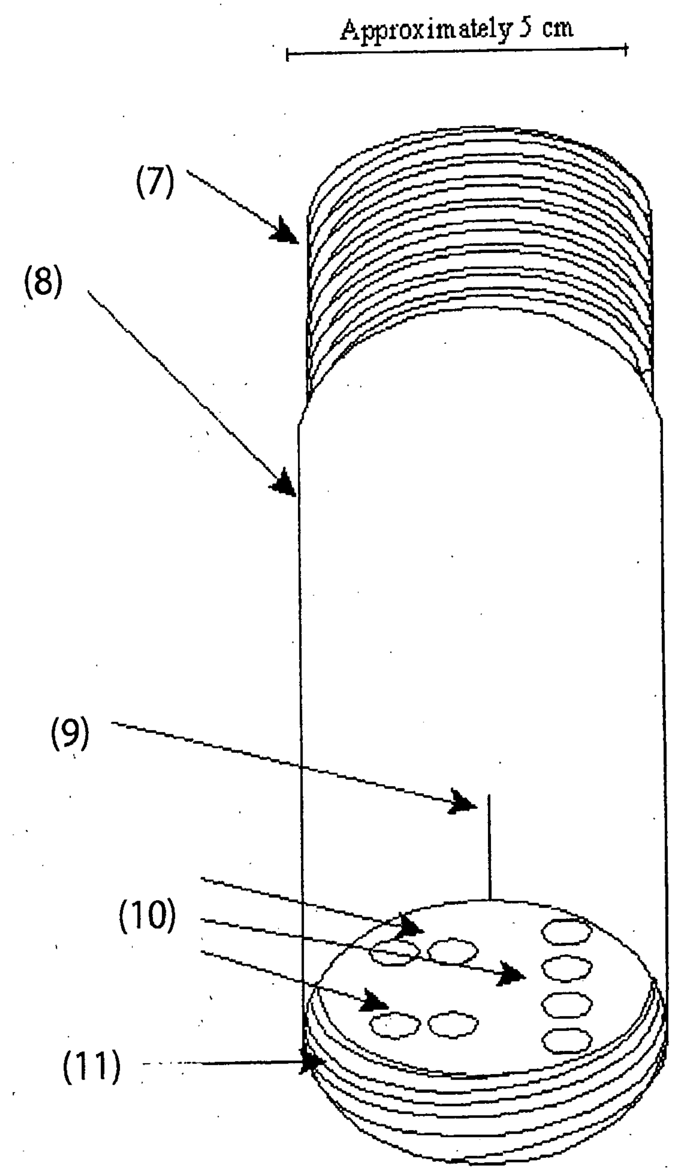


Figure 3: Core Tube and Sensor Setup

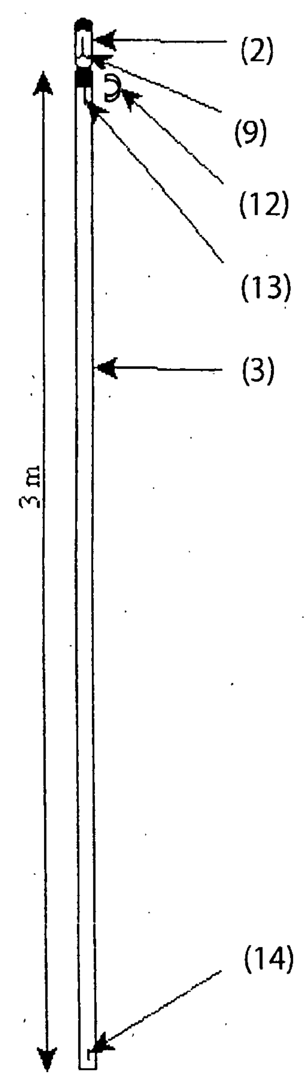


Figure 4: Perspective of the Display Unit